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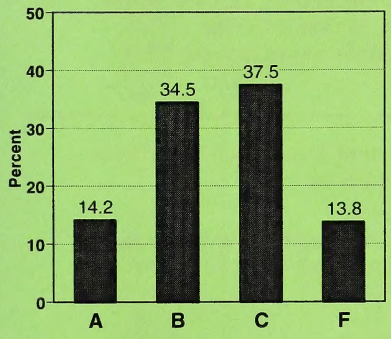
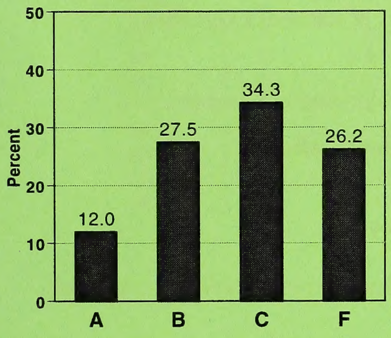
Mathematics 33

Diploma Examination Results
Examiners' Report for January 1999

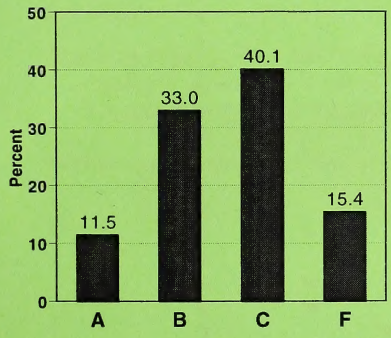
School-Awarded Mark



Diploma Examination Mark



Final Course Mark



The summary information in this report provides teachers, school administrators, and students with an overview of results from the January 1999 administration of the Mathematics 33 Diploma Examination. This information is most helpful when used in conjunction with the detailed school and jurisdiction reports that are provided electronically to schools and school jurisdiction offices. A provincial report containing a detailed analysis of the combined January, June, and August results is made available annually.

Description of the Examination

The Mathematics 33 Diploma Examination consists of 37 multiple-choice questions worth 53%, 12 numerical-response questions worth 17%, and four written-response questions worth 30% of the total examination.

Achievement of Standards

The information reported is based on the final course marks achieved by 5 796 students in Alberta who wrote the January 1999 examination and received a school-awarded mark.

- 84.6% of the 5 796 students achieved the *acceptable standard* (a final course mark of 50% or higher).
- 11.5% of the students achieved the *standard of excellence* (a final course mark of 80% or higher).

Overall, student achievement in Mathematics 33 was satisfactory. The percentage of students who achieved the *acceptable standard* (84.6%) was similar to the percentage for January 1998 (85.6%). Most students were successful when answering questions involving graphs and tables that represented various functions and relations, trigonometric and statistical concepts, and processes related to rational expressions. Some students had difficulty with concepts related to finances and with procedures involving radicals.

Approximately 50.4% of the students who wrote the examination were female. Of these, about 86.0% achieved the *acceptable standard* for a final course mark, compared with 83.2% of the male students. Approximately 13.6% of the female students achieved the *standard of excellence* for a final course mark, compared with 9.3% of male students. The average diploma examination mark was 60.7% for female students and 59.2% for male students.

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Provincial Averages

- The average school-awarded mark was 63.7%.
- The average diploma examination mark was 59.9%.
- The average final course mark, representing an equal weighting of the school-awarded mark and the diploma examination mark, was 62.2%.

Of the 5 796 students who wrote the January 1999 examination and received a school-awarded mark, 396 had written at least one other Mathematics 33 Diploma Examination during the January 1998 to January 1999 period. This subpopulation (396) achieved an examination average of 53.5%, compared with 60.4% for the population (5 400) who first wrote the Mathematics 33 examination in January 1999.

Results and Examiners' Comments

This examination has a balance of question types and difficulties. It was designed so that students achieving the *acceptable standard* will obtain a mark of 50%, or higher, and students achieving the *standard of excellence* will obtain a mark of 80%, or higher.

In the following table, diploma examination questions are classified by question type: multiple choice (MC), numerical response (NR), and written response (WR). The column labelled "Key" indicates the correct response for multiple-choice and numerical-response questions. For numerical-response questions, a limited range of answers was accepted as being equivalent to the correct answer. For multiple-choice and numerical-response questions, the "Difficulty" indicates the proportion (out of 1) of students answering the question correctly. For written-response questions, the "Difficulty" is the mean score (out of 1) achieved by students who wrote the examination.

Questions are also classified by course unit and mathematical understanding.

Course Unit:

RF	Relations & Functions
Q	Quadratic Functions & Equations
PR	Powers & Radicals
RE	Polynomials & Rational Expressions
TR	Trigonometry
ST	Statistics
AML	Annuities, Mortgages, & Loans

Mathematical Understandings:

P	Procedure
C	Concept
PS	Problem-solving

Blueprint

Question	Key	Difficulty	RF	Q	PR	RE	TR	ST	AML	Math Und.
MC1	C	0.941	✓							C
NR1	13.6	0.813		✓						P
MC2	A	0.701					✓			P
WR1	—	0.572						✓		P/C/PS
NR2	15	0.829	✓							PS
MC3	C	0.667					✓			PS
NR3	96.4	0.607					✓			PS
WR2	—	0.552					✓			P/C/PS
MC4	D	0.684		✓						P
MC5	D	0.592				✓				P
MC6	B	0.696							✓	C
MC7	A	0.789	✓							P
NR4	6.25	0.429							✓	PS
MC8	B	0.427							✓	P
NR5	1432	0.716						✓		C
NR6	5.75	0.588				✓				C
MC9	A	0.650				✓				C
MC10	D	0.702				✓				P
MC11	B	0.519				✓				P
NR7	10	0.303			✓					P
MC12	D	0.613			✓					P
MC13	B	0.704			✓					P

Question	Key	Difficulty	RF	Q	PR	RE	TR	ST	AML	Math Und.
MC14	D	0.535		✓						P
MC15	A	0.726		✓						C
NR8	2143	0.661		✓						C
MC16	C	0.610		✓						PS
MC17	B	0.633		✓						C
MC18	A	0.706	✓							C
MC19	D	0.274	✓							C
WR3	—	0.391		✓		✓				P/C/PS
MC20	B	0.916						✓		C
MC21	B	0.707	✓							C
NR9	33.3	0.755						✓		P
NR10	180	0.592							✓	P
MC22	C	0.470							✓	PS
MC23	A	0.704			✓					PS
MC24	C	0.750					✓			P
MC25	D	0.573						✓		P
MC26	C	0.633						✓		C
NR11	324	0.385					✓			PS
MC27	D	0.747		✓						PS
MC28	C	0.594		✓						C
NR12	1.1	0.869				✓				P
MC29	C	0.782					✓			C
MC30	A	0.755					✓			C
MC31	A	0.494			✓					P
MC32	B	0.467	✓							C
MC33	C	0.428					✓			PS
WR4	—	0.483	✓							P/S/PS
MC34	B	0.626					✓			P
MC35	D	0.648						✓		P
MC36	A	0.780	✓							P
MC37	A	0.559	✓							C

Subtests: Machine Scored and Written Response (Average by Subtest)

When analyzing detailed results, please bear in mind that subtest results **cannot** be directly compared. Results are in average raw scores.

Machine scored: 31.4 out of 49

Multiple choice: 23.8 out of 37

Numerical response: 7.6 out of 12

Written response: 10.5 out of 21

Raw Score Average for Machine-Scored Questions by Course Unit

RF	Relations & Functions	6.1	out of	9
Q	Quadratic Functions & Equations	6.0	out of	9
PR	Powers & Radicals	2.8	out of	5
RE	Polynomials & Rational Expressions	3.9	out of	6
TR	Trigonometry	5.7	out of	9
ST	Statistics	4.2	out of	6
AML	Annuities, Mortgages, & Loans	2.6	out of	5

Raw Score Average for Machine-Scored Questions by Mathematical Understanding*

Procedural (P):	13.5	out of	21
Conceptual (C):	12.0	out of	18
Problem Solving (PS):	5.9	out of	10

*Refer to Appendix D of the 1998–99 *Mathematics 33 Information Bulletin,* for an explanation of mathematical understandings.

Multiple-Choice and Numerical-Response Questions

Questions on the examination are organized into scenarios or practical situations that occur in real life. For the January 1999 Mathematics 33 Examination, personnel from the Imperial Oil Resources Limited (Cold Lake), Canmore Nordic Centre, and Edmonton Space & Science Centre assisted teachers in the development of questions and scenarios. The multiple-choice, numerical-response, and written-response questions were integrated within each scenario of the examination, and, where appropriate, questions from the same unit of the course were organized together.

The following table gives results for six machine-scored questions selected from the examination and shows the percentage of students in four groups that answered each question correctly. The comments following the table relate to some of the understandings and skills that students may have used to answer these questions.

Percentage of Students Correctly Answering Machine-Scored Questions

	Question Number					
Student Group	**NR3**	**NR4**	**MC8**	**NR5**	**MC18**	**MC19**
All Students	60.7	42.9	42.7	71.6	70.6	27.4
Students achieving the *standard of excellence* (80% or higher, or A) on the whole examination	94.2	75.9	67.3	84.7	90.2	52.9
Students achieving the *acceptable standard* but not the *standard of excellence* on the whole examination	71.3	46.3	43.3	74.7	74.2	27.5
Students who have not achieved the *acceptable standard* (49% or less, or F) on the whole examination	20.4	19.9	29.8	58.3	53.1	15.6

Use the following information to answer the next question.

> One part of a different support structure is in the shape of an isosceles triangle. The two equal angles each measure 50°, and the two equal sides each measure 75 cm.

Numerical Response

3. The length of the side that is opposite the 80° angle, to the nearest tenth centimetre, is **96.4** cm.

(Record your answer in the numerical-response section on the answer sheet.)

For **numerical-response question 3** students were required to use problem-solving skills related to Trigonometry. Unlike other trigonometry questions in this examination (where a diagram of a triangle is given), this question required students to use the given values of angles and sides to construct their own diagram and to decide between the use of the cosine or sine law. Students that achieved the *acceptable standard* and *standard of excellence* responded well to this question . Results show that this group of students has an improved understanding solving oblique triangles. A few students (3.3%) made the error of using Pythagorean's theorem to find the missing length as 106 cm.

Use the following information to answer the next question.

> In order for an employee to assist the project manager, she had to relocate closer to the job site. To purchase a new house, the employee arranged a $92 000 mortgage over 15 years.

Numerical Response

4. If the monthly mortgage payments were arranged to be $784.83, then the annual interest rate on the mortgage, to the nearest hundredth of a percentage, is __6.25__ %.

(Record your answer in the numerical-response section on the answer sheet.)

Use the following information to answer the next question.

> To have more money available for retirement, one of the senior executives of the oil company planned to save $20 000 over 3 years. His plan consisted of making regular monthly payments at the beginning of each month into the company's annuity, which earned 6% per annum compounded monthly.

8. By referring to an Amount of an Annuity Table, the executive determined that his regular monthly payments would be

A. $158.39
***B.** $505.91
C. $555.56
D. $608.44

Use the following information to answer the next question.

> Management at the oil company asked a statistician to set up a survey to determine customer satisfaction. The following steps were completed to conduct the survey.
>
> **1** Design a survey questionnaire
> **2** Draw inferences from the survey responses
> **3** Analyze the data from the survey
> **4** Collect and organize the data from the survey responses

Numerical Response

5. The order in which the above steps must be completed to conduct the survey is __1__, __4__, __3__, and __2__.

(Record **all four digits** of your answer in the numerical-response section on the answer sheet.)

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18. If $f(x) = -x^2 + 3x - 5$, then $f(a)$, where $a \neq 0$, could be represented by

***A.** $-a^2 + 3a - 5$
B. $a^2 + 3a - 5$
C. $-(ax)^2 + 3(ax) - 5$
D. $(ax)^2 + 3(ax) - 5$

Numerical-response question 4 is a unique question in the Annuities, Mortgages, and Loans unit. Students were required to use problem-solving strategies to find an interest rate from their data booklet. To solve this question, students could divide $784.83 by 92, find the corresponding mortgage chart value in the 15-year column, and read the interest rate from the left or right side. The most common error in finding the interest rate was that students divided $92 000 by $784.83 to get 8.53%.

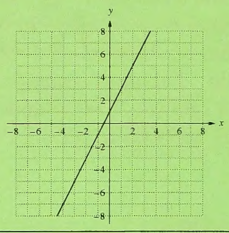
Multiple-choice question 8 is a routine question in the Annuity, Mortgages and Loan unit. Students had to use their Amount of an Annuity Table in the data booklet to find the periodic payment when given the total amount, interest rate, and term. This question seemed more difficult for students, so it discriminated well between students achieving each standard. The most common error made by students was that they chose alternative C by incorrectly dividing $20 000 by 36 months.

Numerical-response question 5, a unique type of question (presented for the first time on this examination and introduced in the 1998–99 Mathematics 33 Bulletin), related to the Statistics unit. Students were asked to sequence four listed processes for conducting a survey. Almost 72% of all students successfully answered this question. Markers liked this style of question to test students' process skills and recommended its use in testing conceptual and procedural understanding in all units.

For **multiple-choice question 18**, students were required to generalize their understanding of functional notation. Students were very successful in substituting a non-numerical term into a quadratic function. Two errors made by students, especially those who did not achieve the *acceptable standard*, were that they squared the negative sign on "a" to get a^2 (alternative B), or that they perceived the substitution of "a" as an added coefficient of x (alternative C).

Use the following information to answer the next question.

A student realized that equations or graphs can be used to find the inverse of linear functions. The equation $y = 2x + 1$ is graphically represented below.



19. The inverse of the function $y = 2x + 1$ is

A. $y = 2x + \frac{1}{2}$

B. $y = 2x - 1$

C. $y = \frac{1}{2}x + 1$

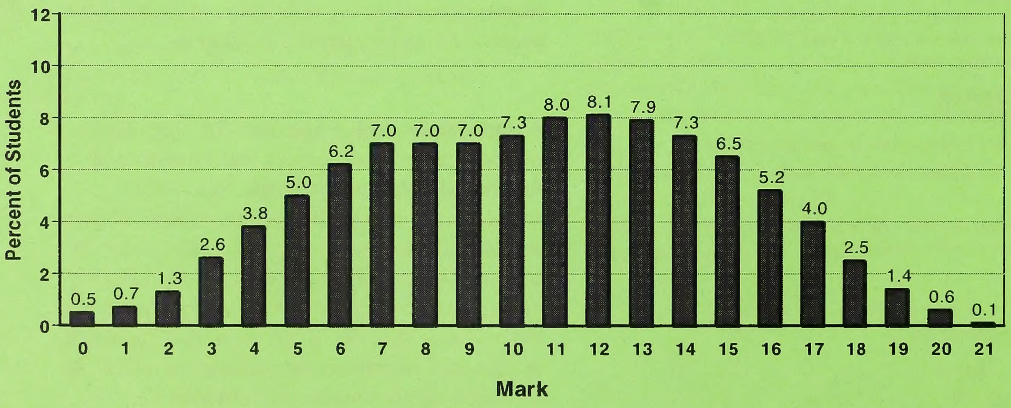
***D.** $y = \frac{1}{2}x - \frac{1}{2}$

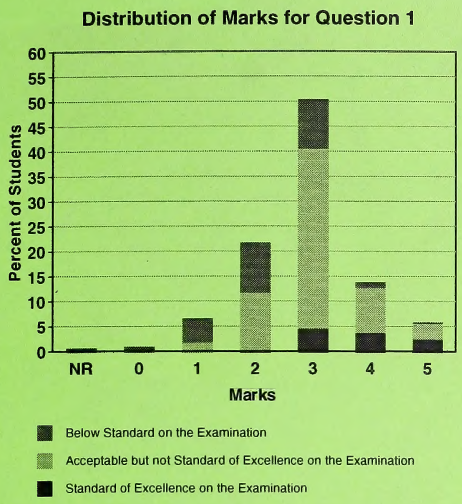
Multiple-choice question 19 is a question that tested the concept of the inverse of a function. In the past, students were simply asked to identify the graph of the inverse of a function: for this examination students had to determine the equation of the inverse function given the equation and graphical representation of the function. Students' understanding of the inverse function will improve if they avoid the common error of changing signs (+1 becoming −1), which resulted in an answer given by alternative B, and instead interchange the variables x and y or reflect the graph of the function through the line $y = x$. Another common error resulted in an incorrect algebraic simplification.

Written-Response Questions

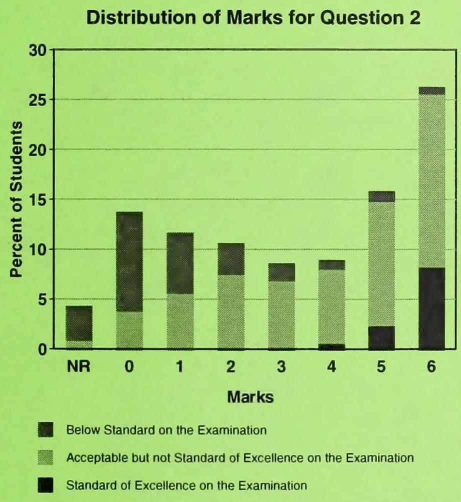
The graph below shows the percentage of students that achieved various marks on the written-response questions. Questions in the written-response section dealt with five of the seven course units for Mathematics 33. Of the students who wrote the examination, 0.5% received no marks for the written-response questions, 51.6% received 11 marks or more (*acceptable standard*), and 8.7% received 17 marks or more (*standard of excellence*) out of 21. The average for the written-response questions was 50.2%.

Distribution of Marks for Written Response





Question 1 required students to interpolate from a scatter plot, explain the direction and strength of the correlation between the two variables, and determine the slope and equation of the line of best fit. The question was marked on a five-point holistic scale, and the average was 2.86 (57.2%). Markers noticed that there were very few "no responses" (0.6%) and that most students attempted all parts of the question. Students were very successful in interpolating the correct value for part a., providing a reasonable explanation for the positive direction of the correlation, and determining the slope of the line of best fit. Markers also identified several weaknesses in students' responses. Many students incorrectly justified the correlation to be strongly based on the close proximity of the points to one another or on the value of the slope of the line of best fit. Some students also used language that lacked clarity and precision to explain their answer in part b. In part c., many students either failed to find the equation of the line of best fit, or wrote the equation without supporting their answer mathematically.



Question 2 required students to solve an applied trigonometry problem involving multiple triangles. The question was marked on a six-point scale, with one point available for part a (calculating and indicating missing measures of angles on the diagram) and five points available for parts b. and c. (applying trigonometric laws or ratios to find missing lengths of triangles). The average for this question was 3.31 (55.2%). Teachers marking this question reported that student responses demonstrated competence in the appropriate selection of a trigonometric law or ratio to solve for the missing side of the triangle. Students were reasonably proficient in referencing their variables with appropriate symbols, using equal signs and mathematical syntax, rounding and providing units in their final answers. Weaknesses in student responses were also identified by markers. A large proportion of students failed to get even one mark on this type of question (18.1%). Some students presented solutions that were hard to follow and were often disjointed. As well, some students had difficulty with correctly completing or processing their trigonometric equations. Markers noted that many students do not realize that the word *determine* in a written-response question means that they must provide not only the final answer, but also the procedures and calculations that lead to this answer.

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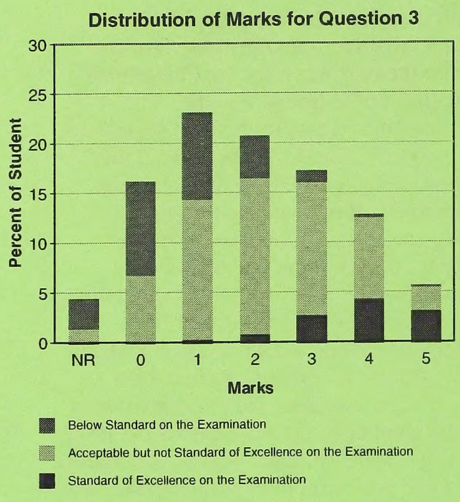
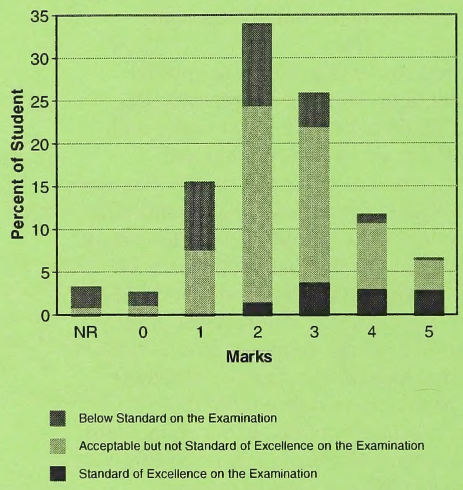


Question 3 required students to demonstrate an understanding of the representation of the various terms of a rational equation reflecting distance-speed-time, to use an appropriate method to solve this equation (given in a simplified quadratic form), and to relate the solution to one of the rational equation's original conditions. The question was marked on a five-point holistic scale, and the average was 1.95 (39.1%). Markers indicated that students were fairly successful in finding the zeros of the quadratic equation by either factoring or substituting values into the quadratic formula. Markers also mentioned that the majority of students correctly identified the expression for part a. Weaknesses in student responses were attributed to conceptual, procedural, and communication errors. Some students misinterpreted the function in part b. to represent a difference in speed instead of time, while others inappropriately tried to solve the quadratic equation in part c. by completing the square or using methods pertaining to solving a linear equation. Some students who used the quadratic formula, made errors in procedures and calculations in their simplification steps. Weakness in communication was also evident; for example, incorrect use of mathematical syntax, lack of units in final answers, a failure to indicate both roots as possible solutions for the quadratic equation, and a failure to provide the rationale (connection to the solutions of x) for the determination of the final answer in part c.



Question 4 required students to interpret a graph pertaining to the electrical power demand of a Space and Science Centre over a 24-hour period. The question was marked on a five-point holistic scale and the average was 2.42 (48.3%). Markers noticed that there were few "no responses" (3.3%) and that the majority of students tried all parts of the question. Students were successful in providing a reasonable explanation of the base load in part a. and for one interval of change in the graph in part c. However, markers were concerned with the large number of students' responses in part c. that failed to provide analysis of more than one interval of change or that did not contain supportive evidence or explanations when more than one change was described. These errors in responses for part c. may have resulted from a misinterpretation of 10:00 P.M. as 10:00 A.M. or a faulty interpretation of the question itself. Another weakness identified by markers was the incorrect use of inequality signs and poor communication of the range for part b.

Overall, markers reported that students used many creative methods to answer all written-response questions. They also felt that these questions were fair and set at an appropriate standard for Mathematics 33 students. Many students would have enhanced their grades by paying attention to detail, reading instructions carefully, and providing solutions that were clearly and logically presented.

For further information, contact Ron Zukowski (rzukowski@edc.gov.ab.ca) or Corinne McCabe (cmcabe@edc.gov.ab.ca) at the Student Evaluation Branch at (780) 427-0010. To call toll-free from outside of Edmonton, dial 310-0000.

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